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Attorney Docket # 5140-16PCON

Express Mail #EV370153704US  
Patent

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

In re Application of  
Georg ICKINGER et al.  
Serial No.: n/a  
Filed: concurrently  
For: Electromechanical Linear Drive

**LETTER TRANSMITTING PRIORITY DOCUMENT**

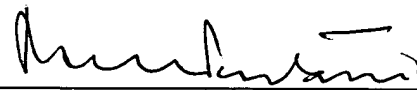
Mail Stop **Patent Application**  
Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

SIR:

In order to complete the claim to priority in the above-identified application under 35 U.S.C. §119, enclosed herewith is the certified documentation as follows:

Austria Application No. A 1196/2001, filed on August 01, 2001,  
upon which the priority claim is based.

Respectfully submitted,  
COHEN, PONTANI, LIEBERMAN & PAVANE

By 

Thomas C. Pontani  
Reg. No. 29,763  
551 Fifth Avenue, Suite 1210  
New York, New York 10176  
(212) 687-2770

Dated: January 30, 2004



74505



# ÖSTERREICHISCHES PATENTAMT

A-1200 Wien, Dresdner Straße 87

Kanzleigeühr € 12,00

Schriftengebühr € 52,00

Aktenzeichen **A 1196/2001**

Das Österreichische Patentamt bestätigt, dass

**Dipl.-Ing. Dr. techn. Georg Ickinger**  
**in A-8010 Graz, Weg zum Reinerkogel 37**  
**(Steiermark),**

am **1. August 2001** eine Patentanmeldung betreffend

**"Bearings for direct drive motors",**

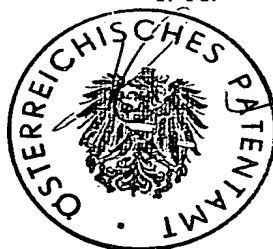
überreicht hat und dass die beigeheftete Beschreibung samt Zeichnungen mit der ursprünglichen, zugleich mit dieser Patentanmeldung überreichten Beschreibung samt Zeichnungen übereinstimmt.

Österreichisches Patentamt

Wien, am 4. Dezember 2003

Der Präsident:

i. A.



**HRNCIR**  
Fachoberinspektor





## 5      **Bearings for High Torque Motor**

### **BACKGROUND OF THE INVENTION:**

10      The target of the current invention is the replacement of in built bearings of high torque motors of larger diameter by less costly application.

The state of art of high torque motors are mounted bearing between the rotor and the stator. For larger hollow motors the bearing are expensive. Above about 150mm bearings with incorporated seal are not available any more.

15      Besides the high accurate mashing several expensive supplies of ball bearings, seals and oil lubrication are costly.

The current invention get down the cost by a  
by combination of:

20      one large bearing  
shaft bearing(s) (5),  
trust roller set(s) (9),  
magnetic bearing set(s),  
hydrodynamic bearing set(s).

25      For high torque motor application using one side open, shaft bearings (5) placed between the side shield (3) and the shaft (6) can take over the centring duty. For longer rotors small trust roller (9) can assist on the open side to avoid vibration and touching of magnets (8) with the stator poles (2).

30      For axial forces small axial thrust bearings take the duty of load and axial forces. Encoder is easy to place at a cavity in the shaft (10)

Several examples for integration the high torque motor to special designs like spindle mechanism, accumulator and drives.

35      To maintain the magnetic gap and avoid vibration, the rotor has to be dynamic inertia adjusted.

## DESCRIPTION OF THE FIGURES

In figure 1 the state of art is shown, having two large roller bearings between the stator (1) and the rotor (4).

- 5 For hollow motors the encoder (11) has to be driven by a belt (12) .  
For axial forces a thrust bearing (14) has to be mounted on the side shield (15).

- 10 Figure 2 is showing the bearing of the rotor by two shaft bearings (5) mounted between the side shield (3) and the shaft (6). The encoder (10) is mounted in a cavity of the shaft. The shaft 6 is fitted to a load portion for example a spindle (7).

Figure 3 is showing the case for an axial force, therefore sperical roller bearings (5a) are used instead of roller bearings as shown in figure 2.

- 15 Figure 4 is showing the shaft bearing with offset position on the side shield (3) and a tubular fixing (3a).

- 20 In Figure 5 the rotor is borne by a bearings (5b) mounted on a fixed rod (6a) and a axial thrust bearing (5c). The space between the hollow spindle (7) and the rotor (4) gives room for a nut (7b) going in and out.

Figure 6 is showing the bearing of the rotor with 3 thrust rollers(9a) on the one side and three thrust rollers on the other side (9b).

- 25 Figure 7 is showing the bearing of the rotor by three thrust rollers on the open side and two shaft bearings (5) on the other side.

Figure 8 is showing the front view of the three thrust roller side.

- 30 Figure 9 is showing special bearings on the open side and two shaft bearing son the other side. The special bearings can be magnetic distance bearings, hydrodynamic bearings or aerodynamic bearings.

- 35 Figure 10 is showing one large bearing (19) between rotor (4) and stator(1) on the open side and one shaft bearing on the other side.



# **INDEX LIST:**

1. stator
2. stator magnetic pole portion
- 5 3. side shield
4. rotor
5. shaft bearing
6. shaft
7. driven portion (spindle)
- 10 8. magnetic poles
9. thrust roller bearing
10. shaft encoder for high torque motor
11. shaft encoder for hollow motor
12. belt for encoder
- 15 13. large hollow rotor bearing with sealing
14. axial hollow rotor bearing
15. Side shield
16. Magnetic distance bearing
17. Hydrodynamic bearing
- 20 18. Aerodynamic bearing
19. Single hollow rotor bearing

What is claimed :

5

1. A high torque motor, providing a controlled rotating motion, having a stationary pole portion (stator) and a rotating hollow rotor, wherein the bearing of the hollow rotor consists of a combination of at least one set of:

10

one large bearing

shaft bearing(s),

trust roller set(s),

slide bearing set(s),

15

magnetic bearing set(s),

hydrodynamic bearing set(s)

aerodynamic bearing set(s).

2. A high torque motor, according to claim 1, and said hollow rotor is cup shaped and the tubular rotor section is connected to a flange and said flange is connected to a shaft on the closed side of the hollow rotor, and a side portion is connected to the said stator, wherein the: open side of the hollow rotor is having a full diameter bearing between stator and hollow rotor, and the shaft is having a small bearing between the shaft and the said side portion. (One large bearing. FIG.: 10)

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3. A high torque motor, according to claim 1 and said hollow rotor is cup shaped and the tubular rotor section is connected to a flange and said flange is connected to a shaft on the closed side of the hollow rotor, and a side portion is connected to the said stator, wherein the: open side of the hollow rotor is cantilevered mounted to the said side portion and the shaft is having a set of two bearing between the shaft and the said side portion. (2 Shaft bearings. FIG.: 2)

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4. A high torque motor, according to claim 1 wherein:

at least one side of the hollow rotor is guided by, at least 3 trust rollers mounted on the said stator having the same distance to the axis of the rotor and hollow rotor (One/two Trust roller sets, FIG.: 6, 7, 8)

5      5. A high torque motor, according to claim 1  
       wherein:  
       one side of the hollow rotor is guided by, a set of at least 3 magnetic bearings mounted on the said stator having the same distance to the axis of the rotor and hollow rotor the other side is having at least one shaft bearing.  
 10      (One/two magnetic bearing sets, FIG.: 9).

      6. A high torque motor, according to claim 1,  
       wherein:  
       at least one side of the hollow rotor is guided by, a set of at least 3 hydrodynamic bearings mounted on the said stator having the same distance to the axis of the  
 15      rotor and hollow rotor  
       (One/two hydrodynamic bearing sets, FIG.: 9).

      7. A high torque motor, according to claim 1,  
       wherein:  
       at least one side of the hollow rotor is guided by, a set of at least 3 aerodynamic bearings mounted on the said stator having the same distance to the axis of the  
 20      rotor and hollow rotor  
       (One/two hydrodynamic bearing sets, FIG.: 9).

      8. A high torque motor, according to claim 1,  
       wherein:  
       the rotor is borne on a shaft with two shaft bearings or on two sliding bearings.  
       (sliding bearing sets, FIG.: 5).  
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**SUMMARY OF THE INVENTION:**

The target of the current invention is the replacement of in built bearings of high torque motors of larger diameter by less costly application by combination of:

- 5 one large bearing
- shaft bearing(s) (5),
- trust roller set(s) (9),
- magnetic bearing set(s),
- hydrodynamic bearing set(s).

10 The cost of roller bearings of diameter larger than 150 mm are high and integrated seals are not available. The machining of stator (1) and rotor (4) must be accurate for bearings and supplies are expensive.

For high torque motor application using one side open, shaft bearings (5) placed between the side shield (3) and the shaft (6) can take over the centring duty. For longer rotors small trust roller (9) can assist on the open side to avoid vibration and touching of

15 magnets (8) with the stator poles (2).  
For axial forces small axial thrust bearings take the duty of load and axial forces.  
Encoder is easy to place at a cavity in the shaft (10)

20 Several examples for integration the high torque motor to special designs like spindle mechanism, accumulator and drives.

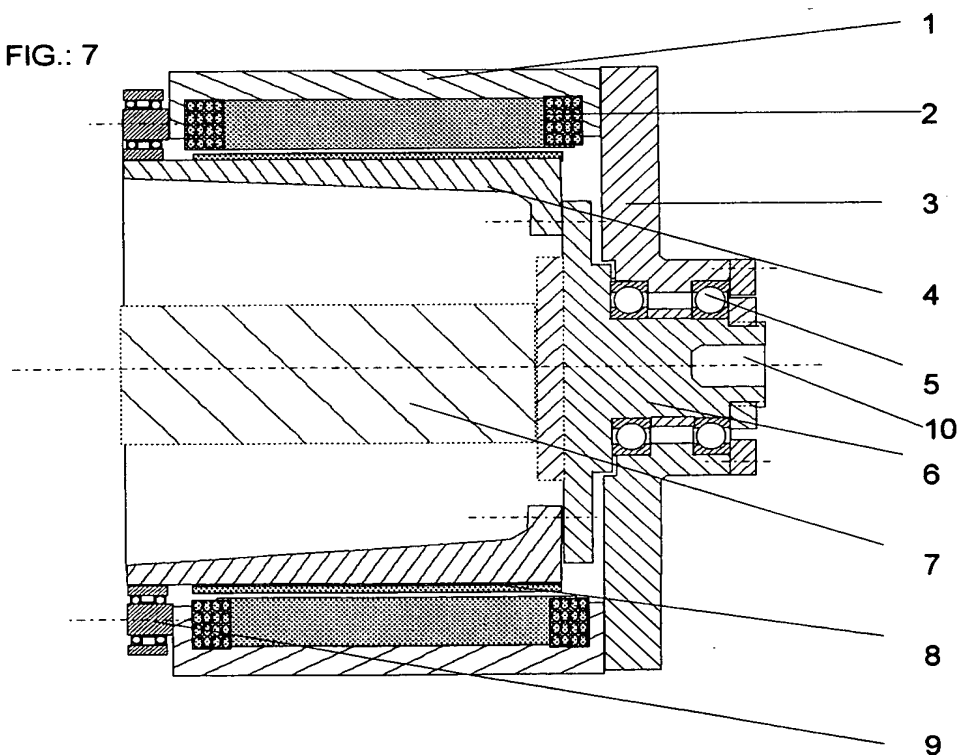
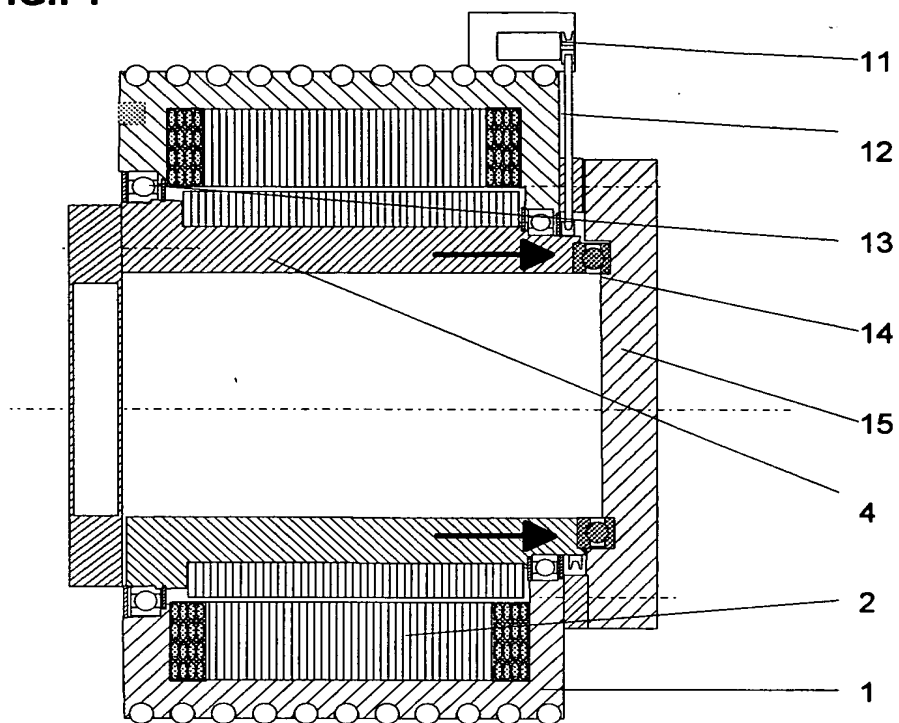
**FIG.: 7**

FIG.: 1



5 FIG.: 2

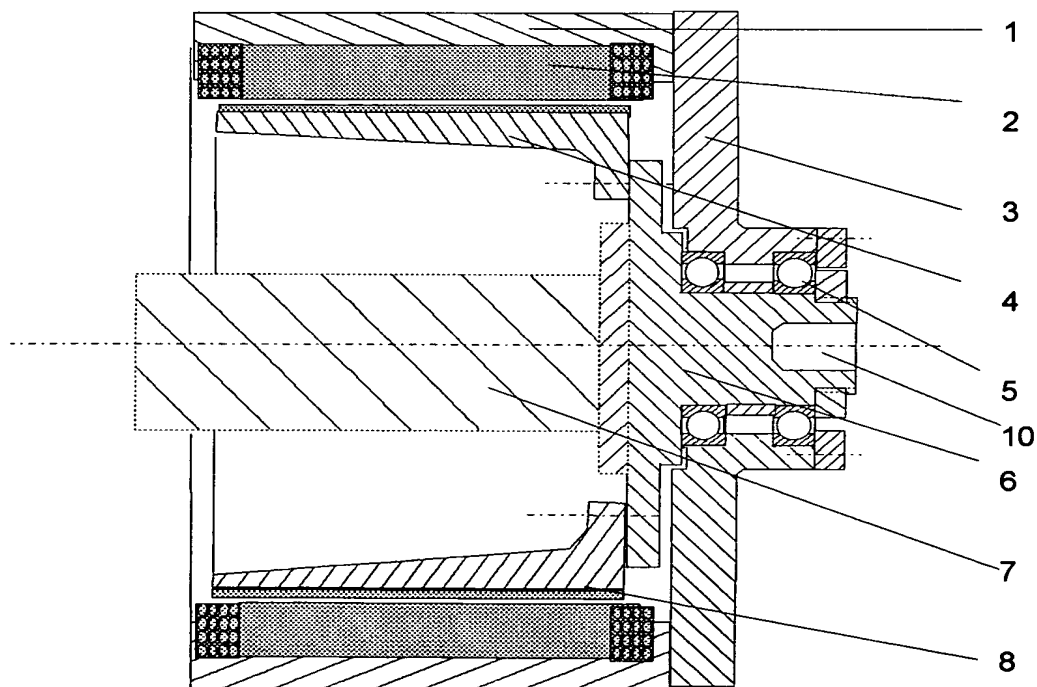
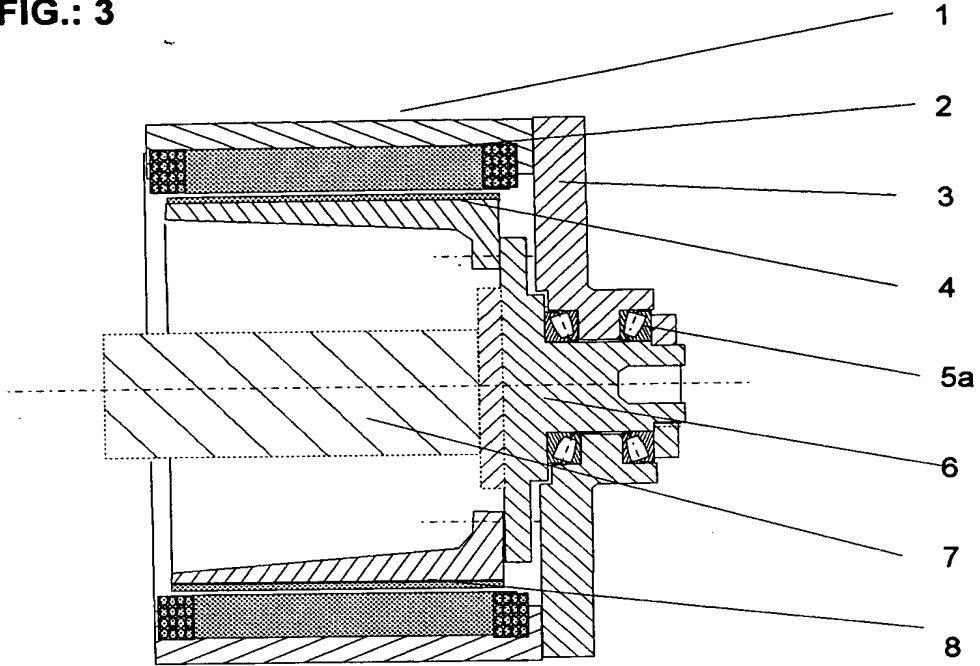


FIG.: 3



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FIG.: 4

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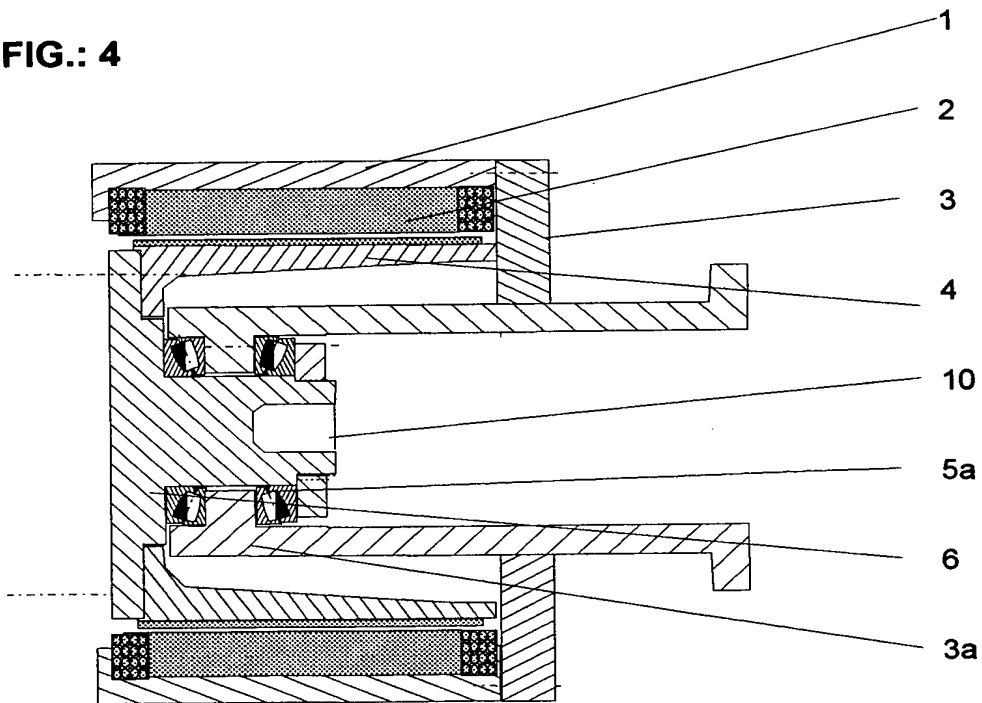
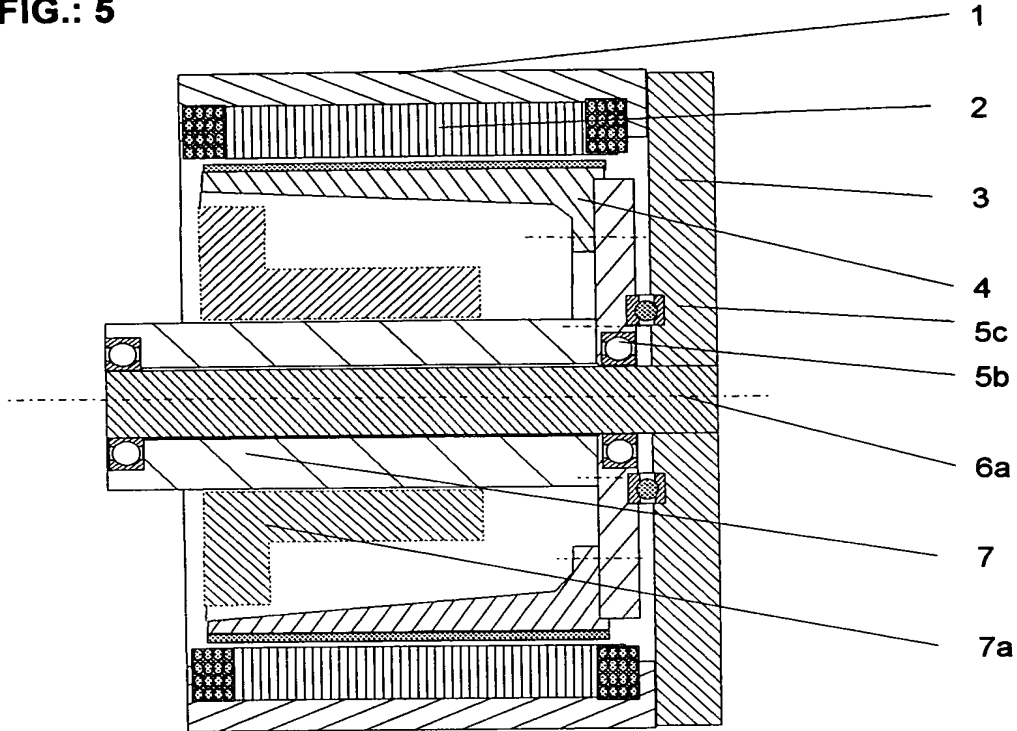


FIG.: 5



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FIG.: 6

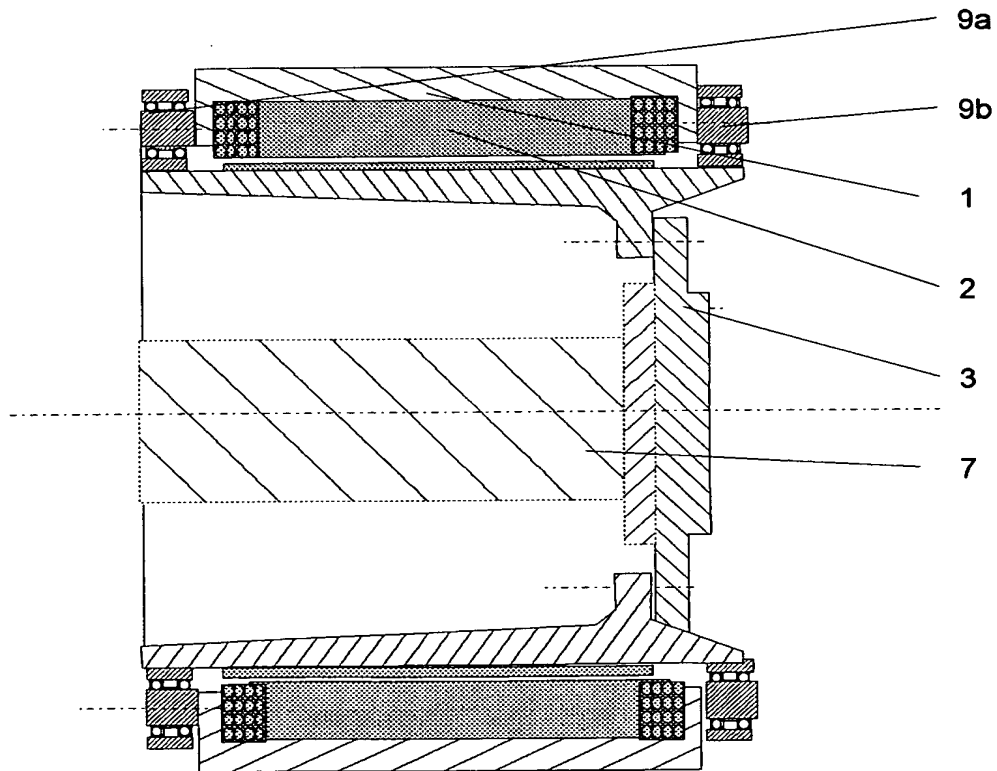
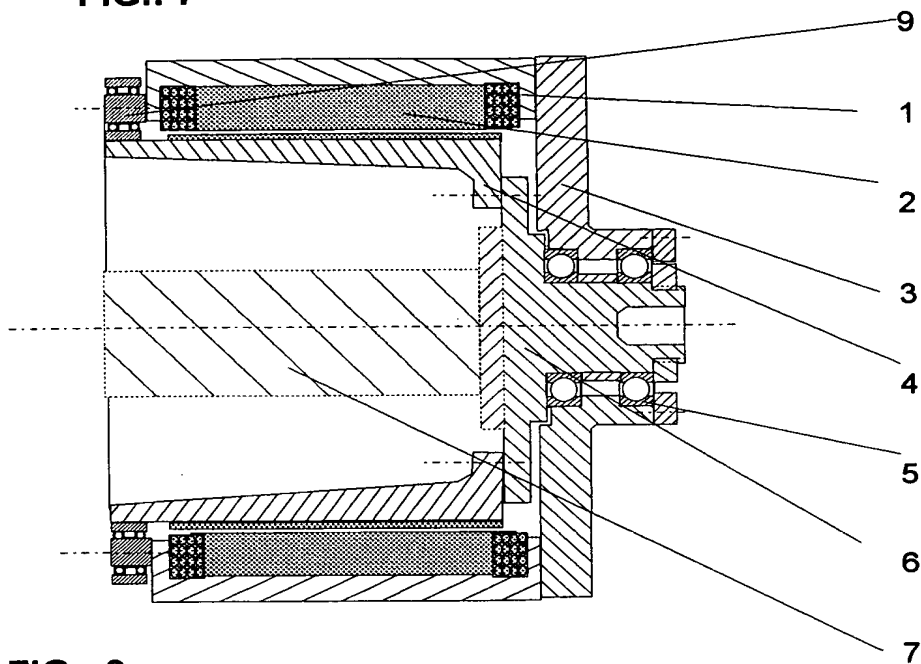


FIG.: 7



5 FIG.: 8

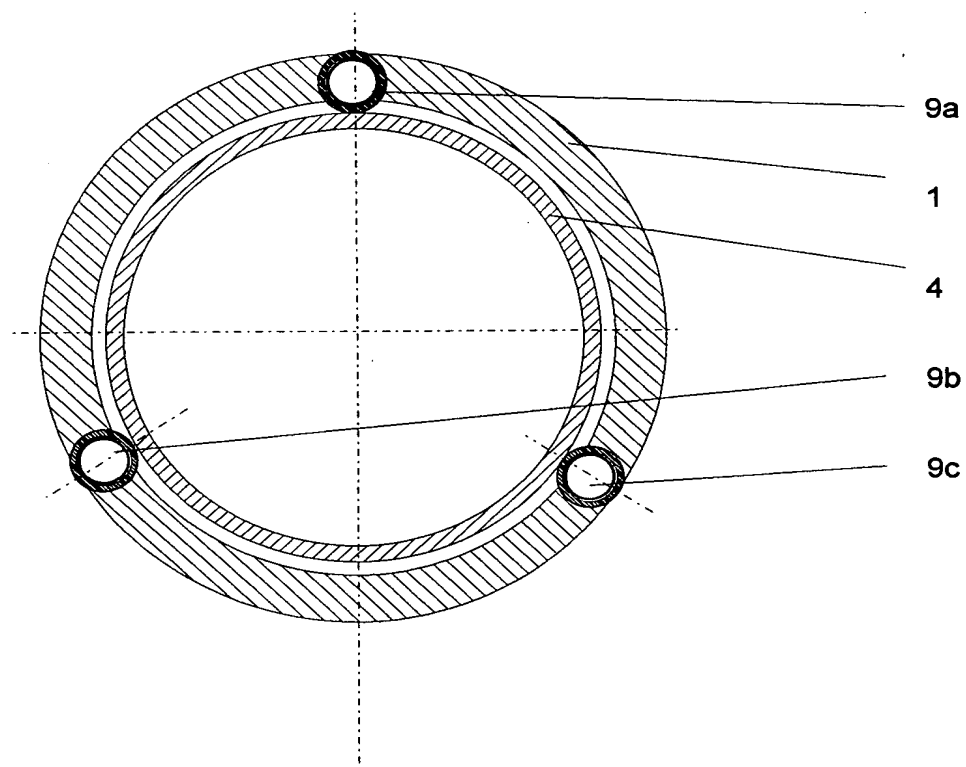
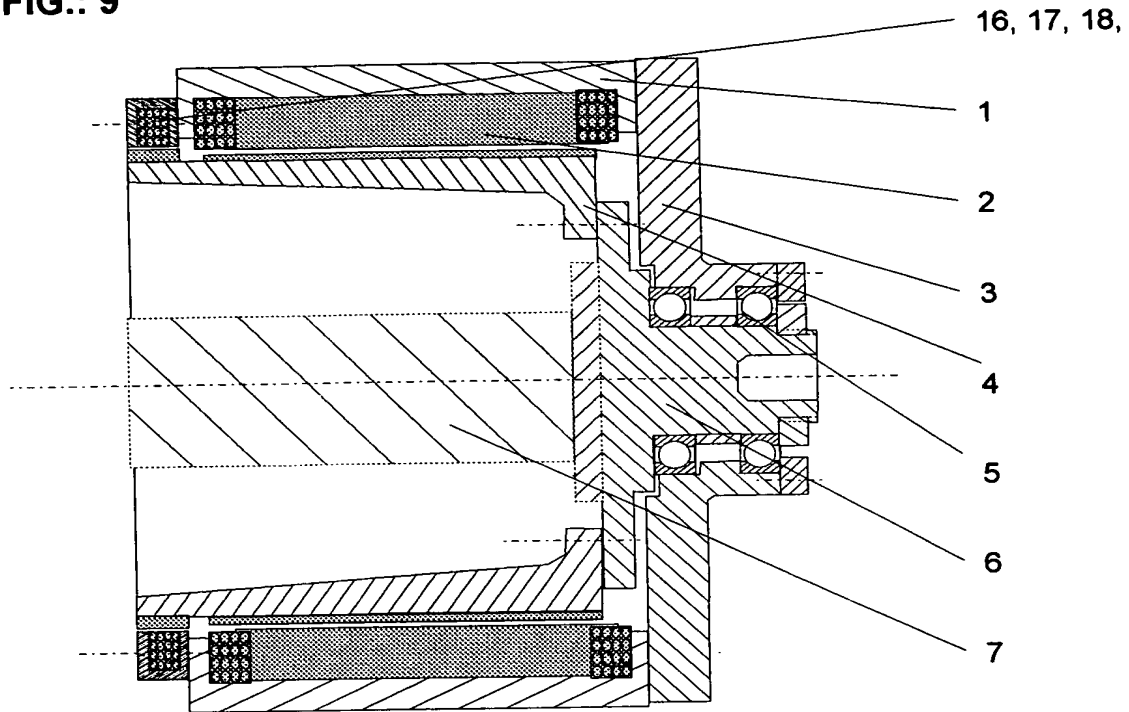


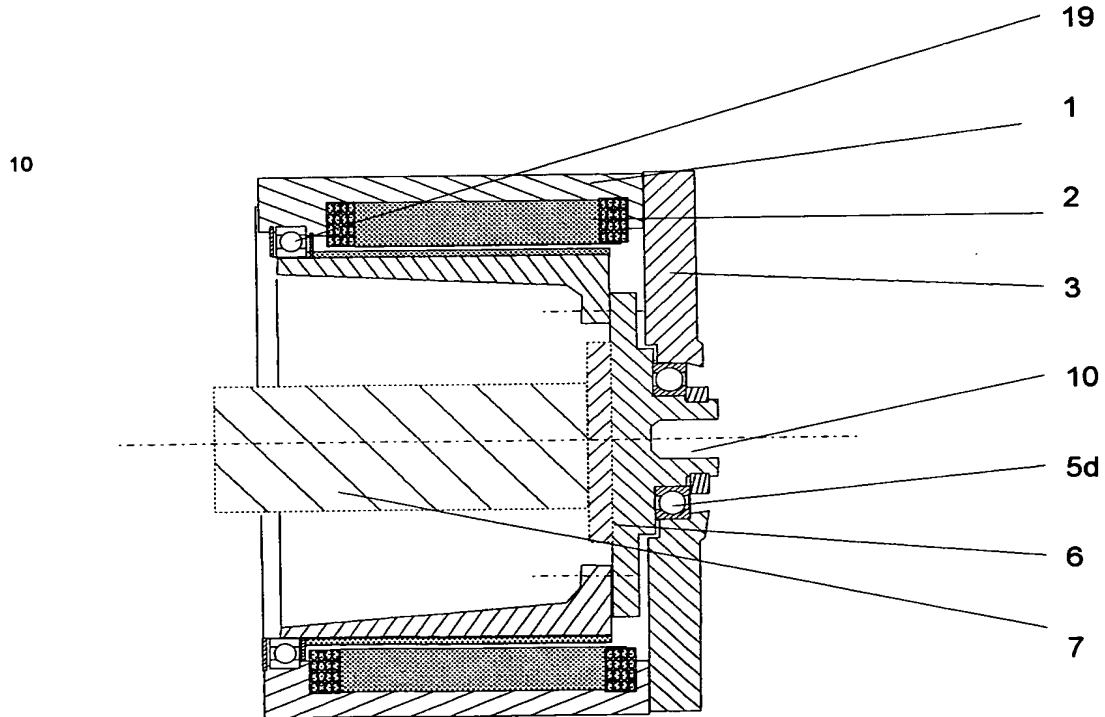


FIG.: 9



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FIG.: 10



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